The Mixed Effects of Advanced Cockpit Systems on Pilot Performance

Steve Casner (NASA Ames Research Center)

Multiple systems in the advanced cockpit (not just glass displays).

We studied the effects of several on pilot performance, individually.

- How does each system affect:

  Pilot Error
  Workload
  Awareness

- How do pilots *think* advanced cockpit systems affect them?

Found that each system is unique: each introduces advantages and disadvantages … and that pilots are not always aware of them.

GPS

Pilot Error

GPS (Like VOR) Requires Mastery of Procedures

Practice “made perfect” … when procedures were supported by visual cues on the interface.

Problems persisted when procedures required rote memorization of steps.

MOST CONCERNING:

Not knowing what to do next …

GPS

Pilot Error
Logic and Modes Can Be Confusing

?

MOST CONCERNING:

Mode confusion (e.g., sequencing vs. non-sequencing)

Sourcing errors

Persistant …

Pilots seemed to have a general awareness of these issues.

Compared to VOR, pilots committed fewer errors during some phases of flight (missed approach), and more errors during others (initial setup, approach).

GPS

Workload

Workload lower during predictable stretches …

… and higher when (re)configuration of the unit was needed.

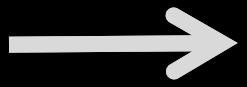
No overall difference between VOR and GPS.

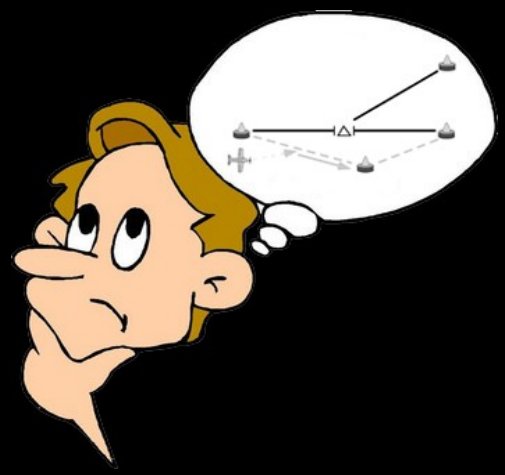
GPS with MOVING MAP

Some benefits are readily apparent.

GPS with MOVING MAP

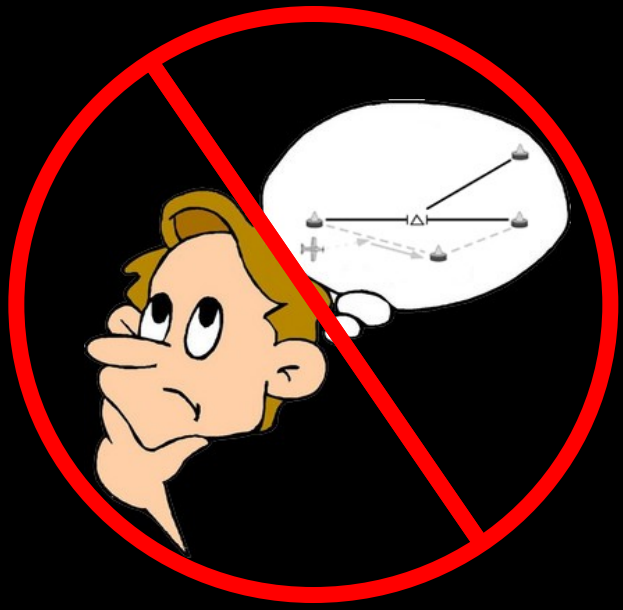
Navigational Awareness





VORs and ADFs make pilots build pictures in their heads.

Navigational Awareness



Pilots don’t seem to build pictures in their heads when using GPS and maps.

Is “in the cockpit” as good as “in the head”?

MOST CONCERNING:

When the GPS and map become inoperative

Navigation skill atrophy or extinction

Pilots seem less aware of the effects on awareness

ELECTRONIC FLIGHT INSTRUMENTS

No difference in errors (altitude, course, or speed excursions) or reported workload after some initial practice.

CONCLUSIONS

Advanced cockpit systems introduce advantages and disadvantages.
Our results pointed to the computers more than the displays.
Some mismatch between pilot beliefs and measure effects.
Pilots state an overwhelming preference for using advanced cockpit systems.

Moving Forward:

- Interface Design: visible cues, simple mental models, make “wrong” look wrong.
- Particular attention to route modifications and transitions (modes).
- Re-engaging the pilot: Do we have to automate everything?
- Develop error procedures and error training.
- Raising awareness of automation effects.

Moving Forward (cont.):

- Continue the accident analyses to isolate the effects of specific cockpit systems.

"Glass" vs. "conventional" compares airplanes that are probably more similar than they are different:

Moving Forward (cont.):

- Accident reports could benefit from more details about equipment installed.

A TEMPLATE?

Navigation: VOR GPS BOTH
Autopilot: Y N
Moving Map: Y N
Cockpit Weather: Y N
Elec. Flt. Instr.: Y N
Traffic Alerting: Y N
Terrain Display: Y N

- Flight data recording (including button presses and knob twists) will provide details about equipment *in use*.

MORE INFORMATION:

stephen.casner@nasa.gov